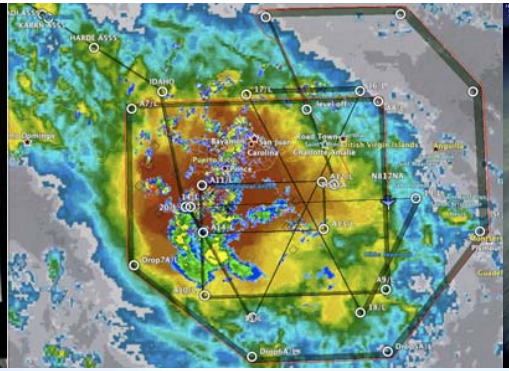
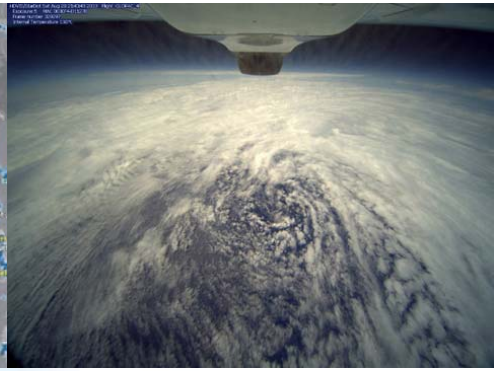


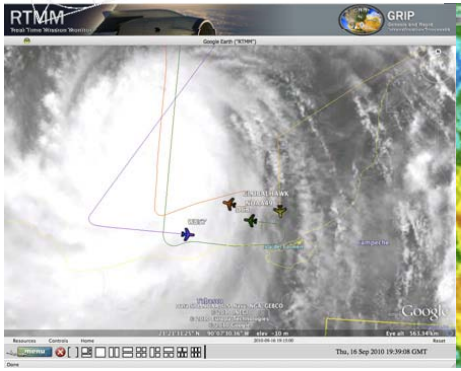


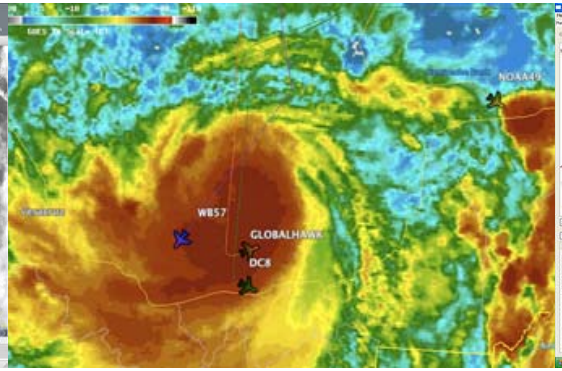
Coordinating Aircraft During Field Campaigns: Real Time Mission Monitor Tool

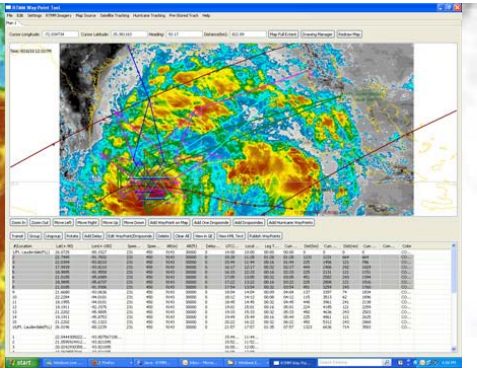
Presentation to Dynetics

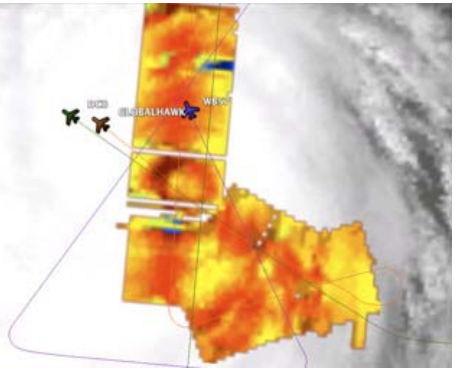
18 October 2012

UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE









Current Team Members

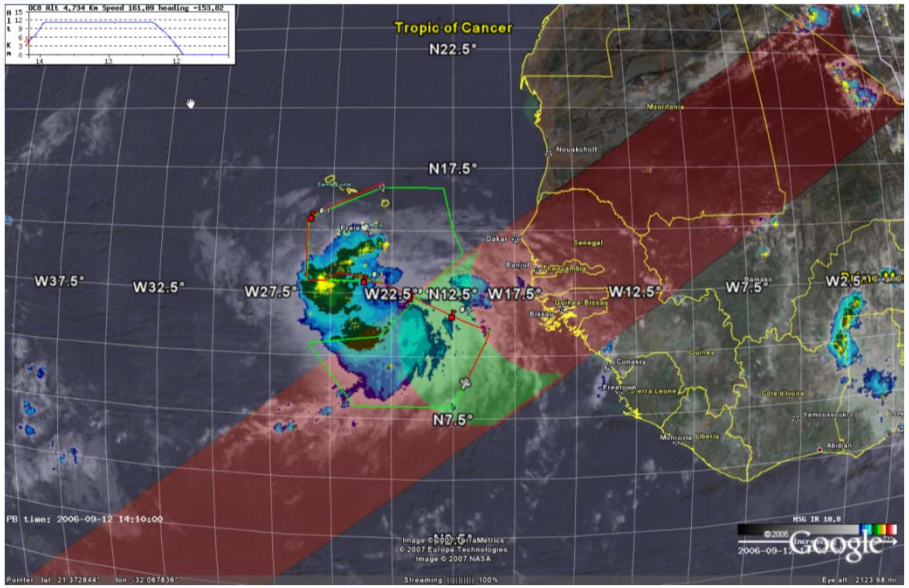
Name	*Organization*	*Role*
Richard Blakeslee	NASA MSFC	Co-Principal Investigator
Michael Goodman	NASA MSFC	Co-Principal Investigator
John Hall	UAHuntsville ESSC	Software Developer RTMM
Matt He	UAHuntsville ESSC	Software Developer Waypoint Tool
Michele Garrett	UAHuntsville ITSC	Systems Administrator
Paul Meyer	NASA MSFC	Systems Manager
Kathryn Regner	UAHuntsville ITSC	Systems Engineer

Real Time Mission Monitor

"Making Science Easier"

The Real Time Mission Monitor (RTMM) is an interactive visualization application that provides situational awareness and field asset management to enable adaptive and strategic decision making during airborne field experiments.

- Integrates satellite, airborne, and surface data sets
- Tracks airborne vehicle state information
- Displays model and forecast parameter fields
- Utilizes distributed Web-based architecture



To paraphrase the BASF™ television commercial:

"We don't make the science, we make the science easier"

RTMM Applications

"Making Science Easier"

RTMM supports all phases of field experiments

- Pre-flight planning
  - Model and forecast fields
  - Satellite overpass predicts
  - Waypoint Planning Tool
- In-flight monitoring and adaptive flight strategies
  - Operations center focal point
  - Current weather conditions
  - Plane-to-plane data transfer
- Post-flight analyses, research, and assessments
  - Encapsulate and replay missions

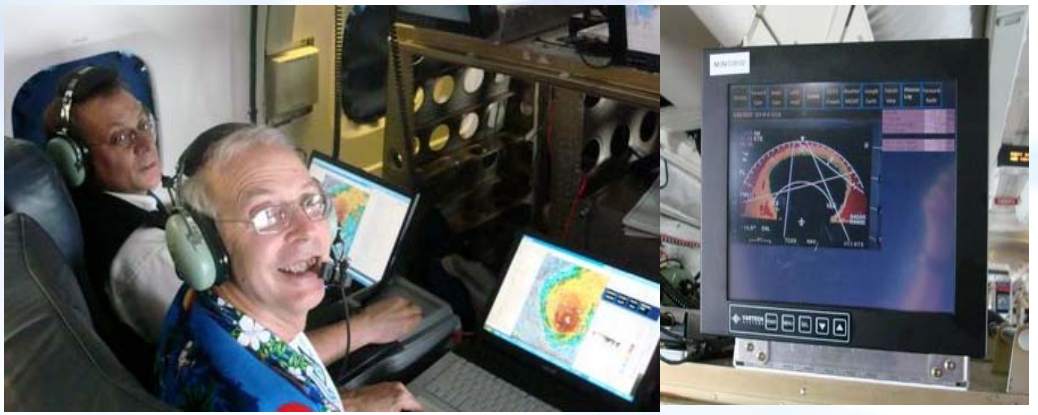
Matt He works aboard the NASA DC-8 during a flight over the Gulf of Mexico, Tuesday, Aug. 17, 2010. Photo Credit: (NASA/Paul E. Alers)

RTMM User Base

"Making Science Easier"

RTMM available for use by user base that includes:

- *Research Scientists*
- *Program and Project Managers*
- *Pilots and Flight Engineers*
- *Educators and Students*
- *Media and Public Affairs*
- *Science Attentive Public*



RTMM (left) and aircraft observation (e.g., radar image of eye shown in right image) provided key "eyes" and guidance.

RTMM used in the cockpit of the DC-8 during GRIP on September 6, 2010.

RTMM enables:

- *Real time interactions and collaborations*
- *Post-flight mission review and case study development*

RTMM Features

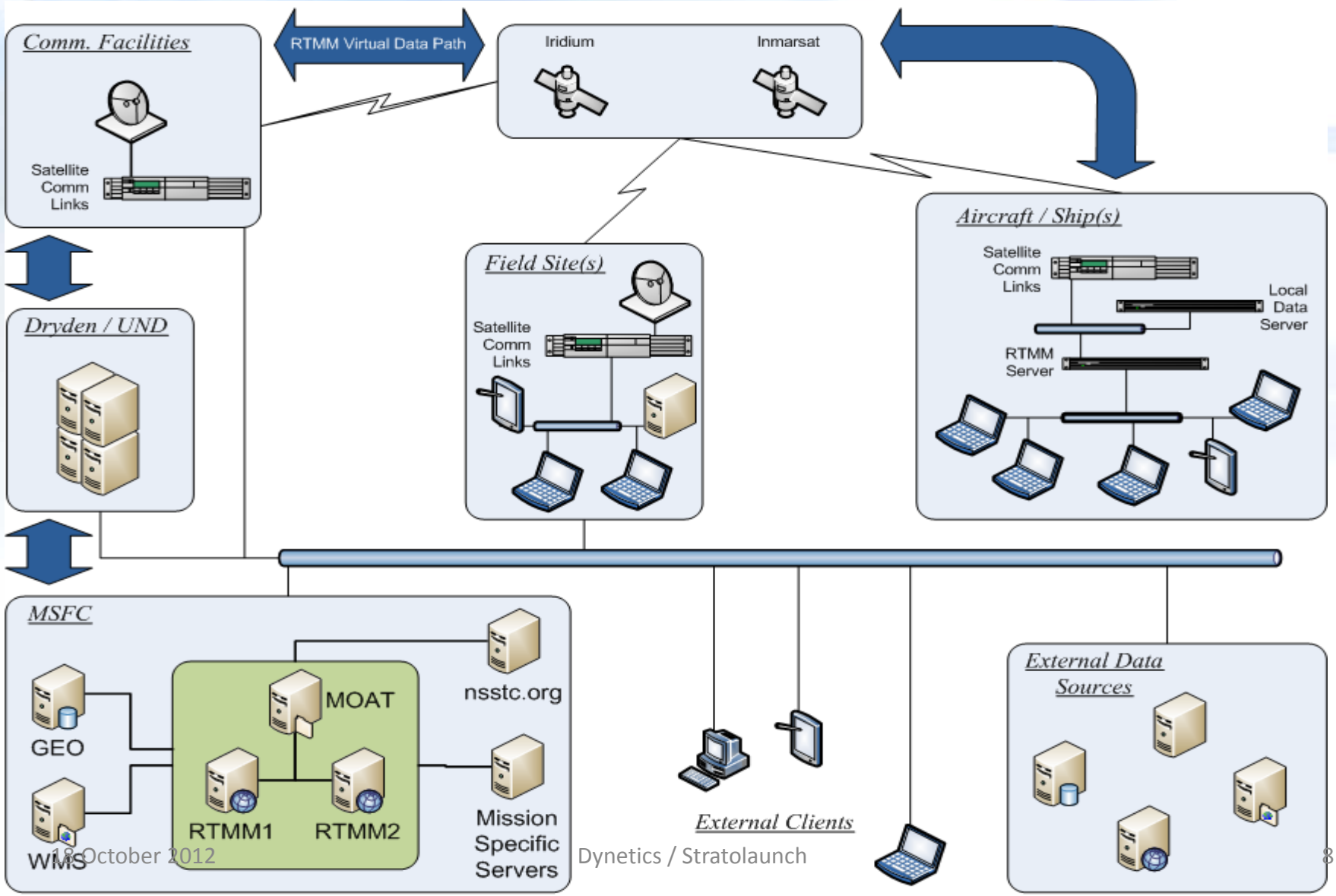
"Making RTMM Better"

- Powerful science decision-making tool
  - Built upon a service oriented architecture
  - Seamlessly integrates multiple applications
  - Monitor and manage airborne assets in NASA Earth science ground validation and field campaigns
- Operate RTMM from a web portal
  - Use applications on a common framework for science data visualization and airborne mission management
- Simplify , enhance and expand the user interface and functionality

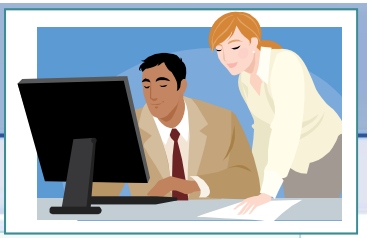
RTMM Architecture

- Utilizes Google Earth (GE) Plug-in Applications Programming Interface
- Standard access methods for data, tools and services and to enable sharing of resources
  - e.g., Keyhole Markup Language (KML), Sensor Observation Service (SOS)
- Data Base Management System (DBMS)
  - Maintains information on local and remote data resources, tools and projects in a central, web accessible location

RTMM System Topology



RTMM Components



RTMM Data Sources
RTMM Components
3rd Party Products

External Data Sources: satellite, aircraft, surface data and models

Server Side RTMM

- Ingest, Archive & Processing
- Authentication Services
- Local XChat / IRC Services
- Catalog Services
- Data Services
- ⋮

Local Data Sources

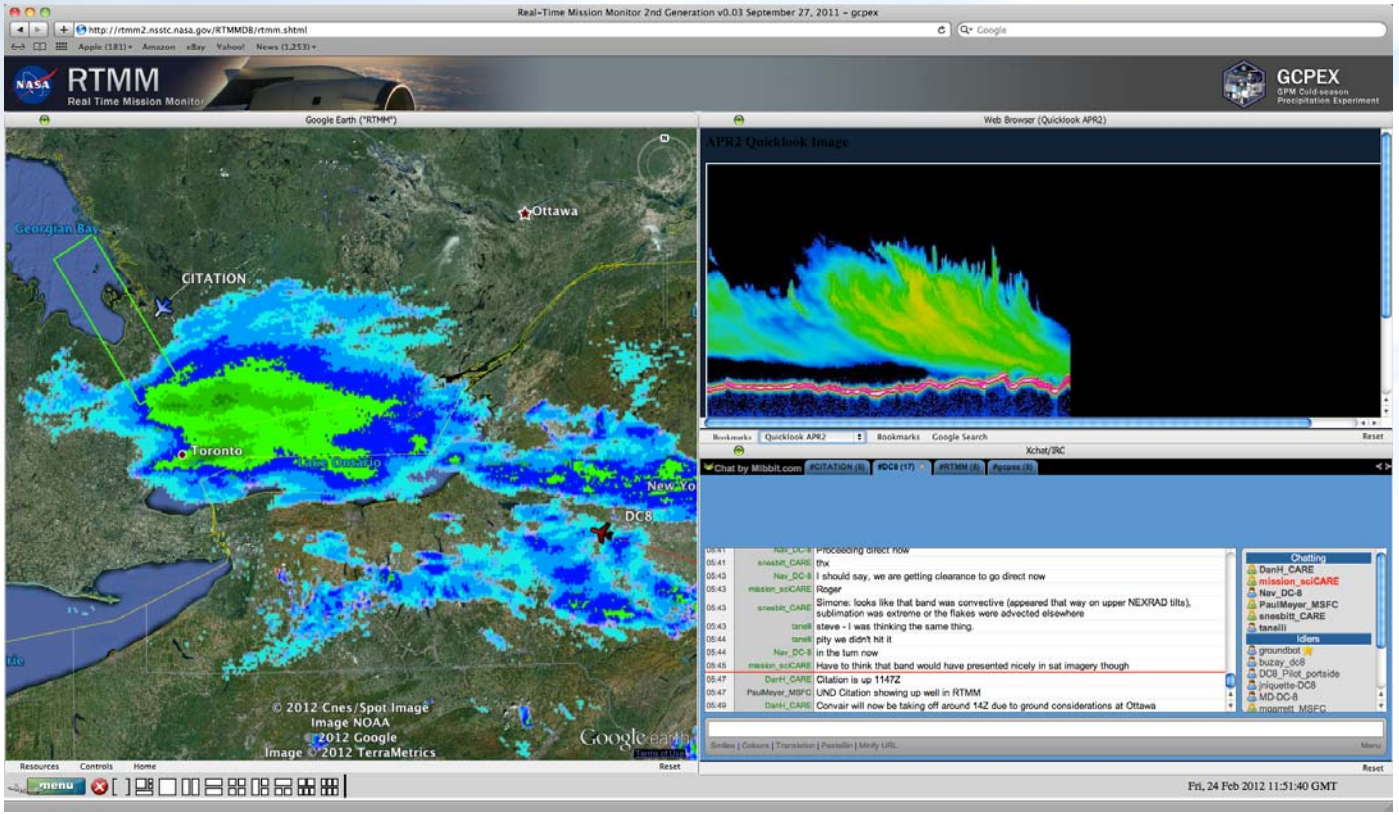
Data & Tools Catalog

Client Side RTMM 2nd Generation

- Mission Designer
- 4D Virtual Globe (GE)
- Waypoint Planning Tool
- Web Viewer
- XChat / IRC Client
- Graphs
- Data & Tools Registration
- ⋮

RTMM User Interface

- Multiple windows within the interface to support multi-tasking using different RTMM tools
- Many different layouts possible
- Easy set-up and configuration
- Integrates and displays multiple data sources & types, video and text



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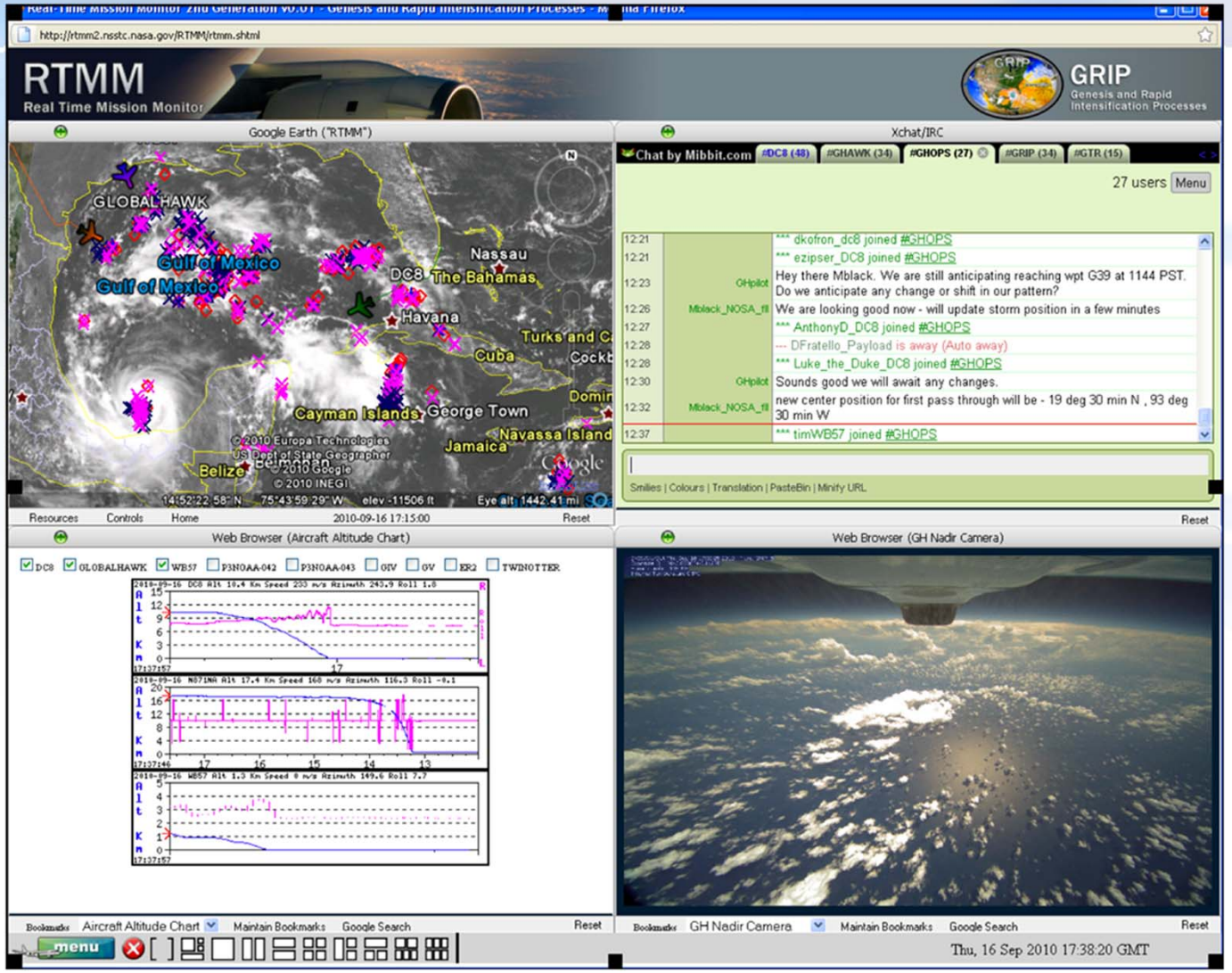


Screen shot on 16 Sept as Global Hawk, WB-57, and DC-8 enter the Gulf of Mexico for a rendezvous with Hurricane Karl

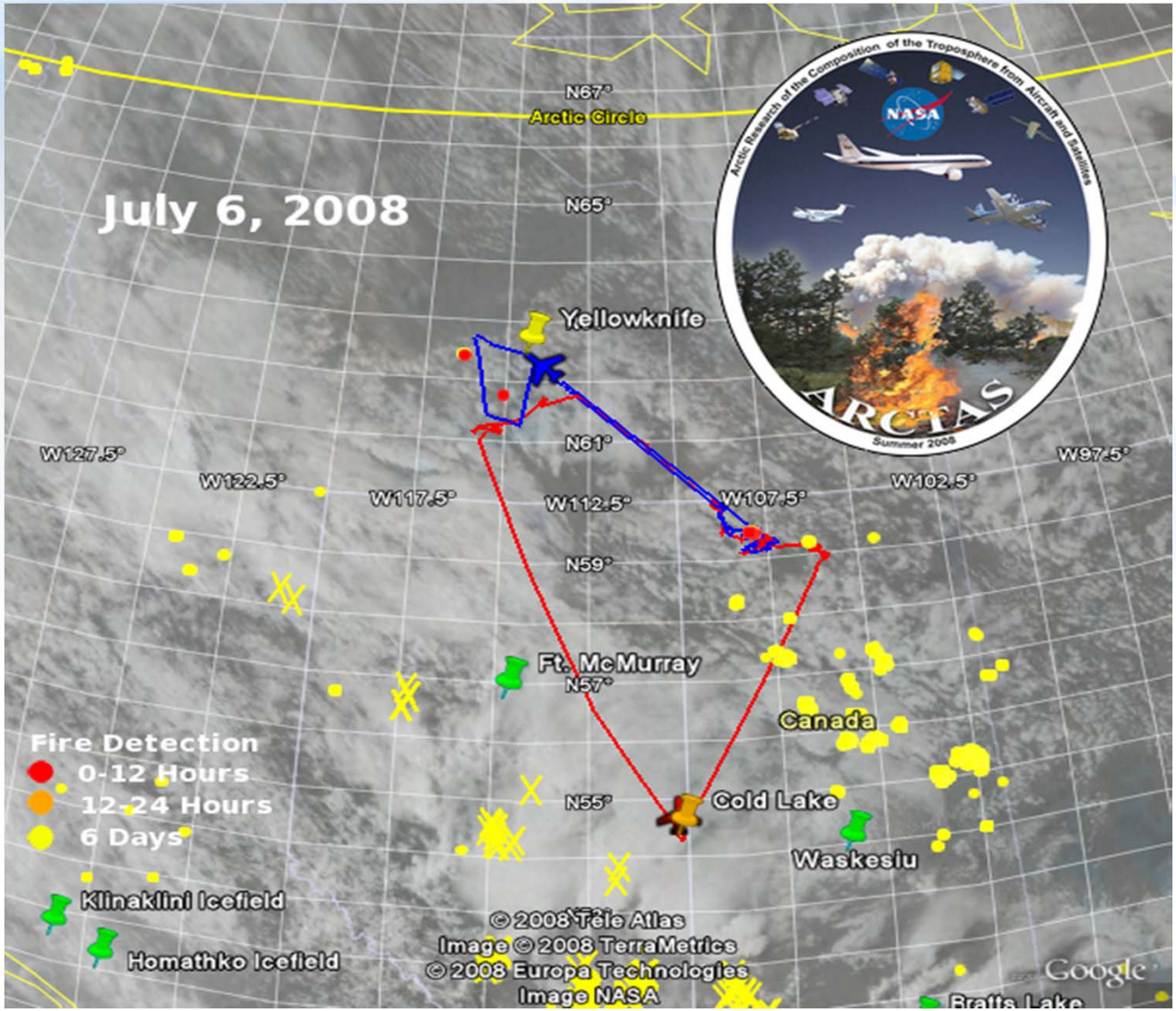
RTMM Supports ARCTAS 2008

Arctic Research of the Composition of the Troposphere from Aircraft and Satellites

July 6, 2008

NASA DC-8 (red)

B200 (blue)

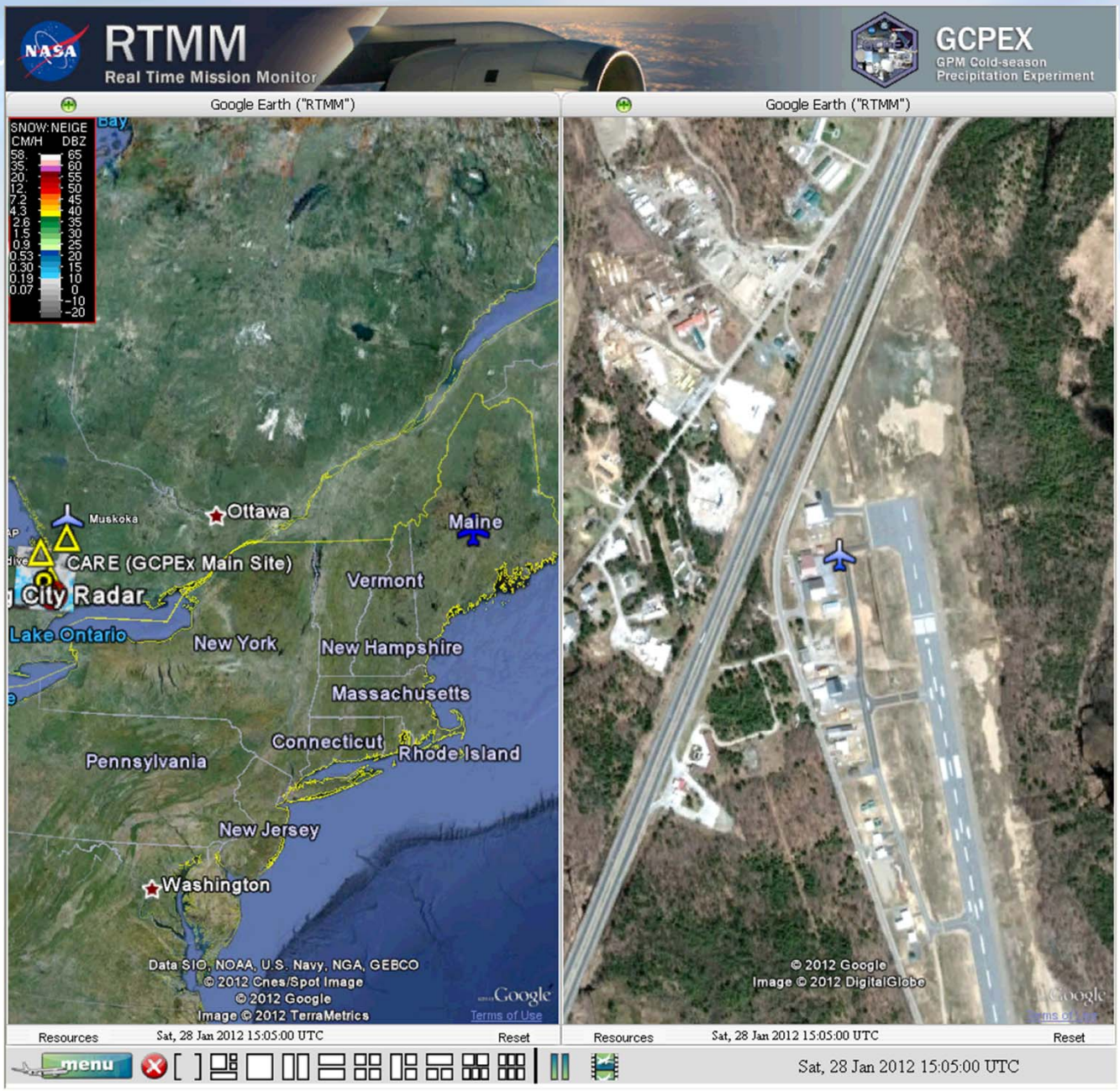


RTMM Supports GCPEx 2012

Global Precipitation Mission (GPM) Cold-season Precipitation Experiment (GCPEx)

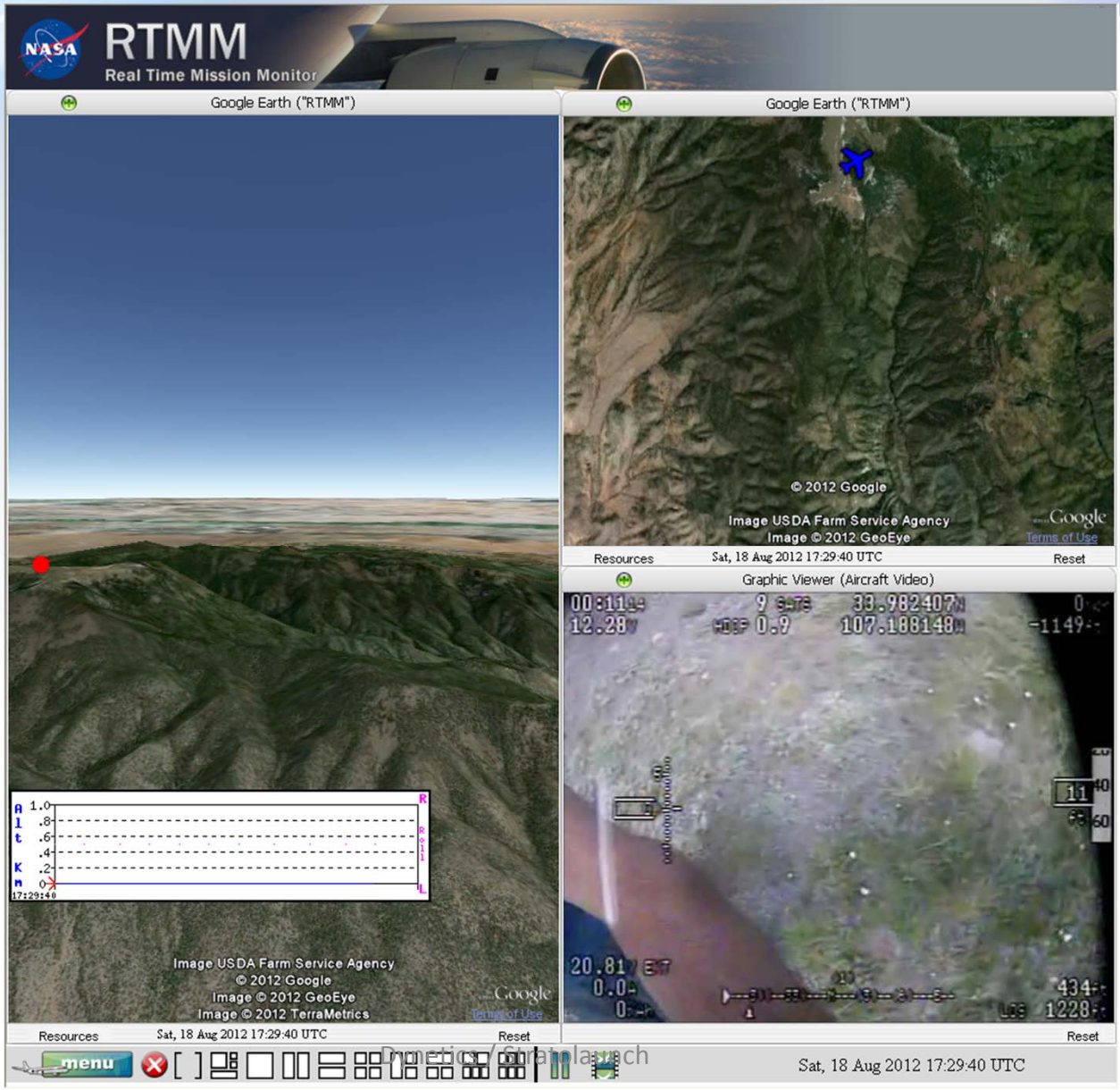
January 28, 2012
NASA DC-8 (blue)
UND Citation (white)

CARE Radar underlay



NSF Nimbus Experiment 2012

Spear small UAV flight at Langmuir Lab near Socorro NM August 18, 2012

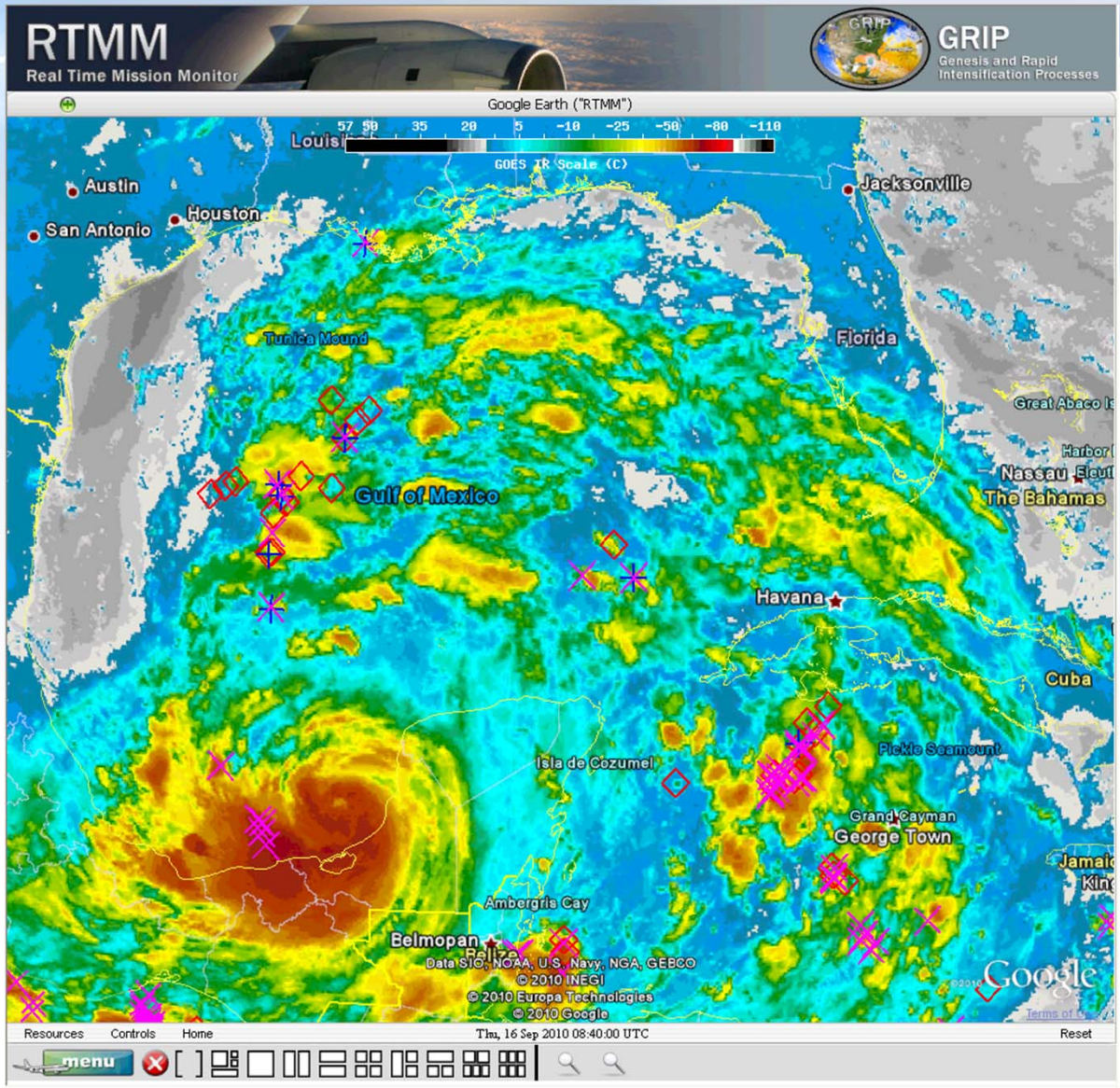


GRIP Hurricane Experiment 2010

Genesis and Rapid Intensification Processes

Hurricane Karl on September 16, 2012.

Seven aircraft fly over and through the storm as it approached Mexican coast



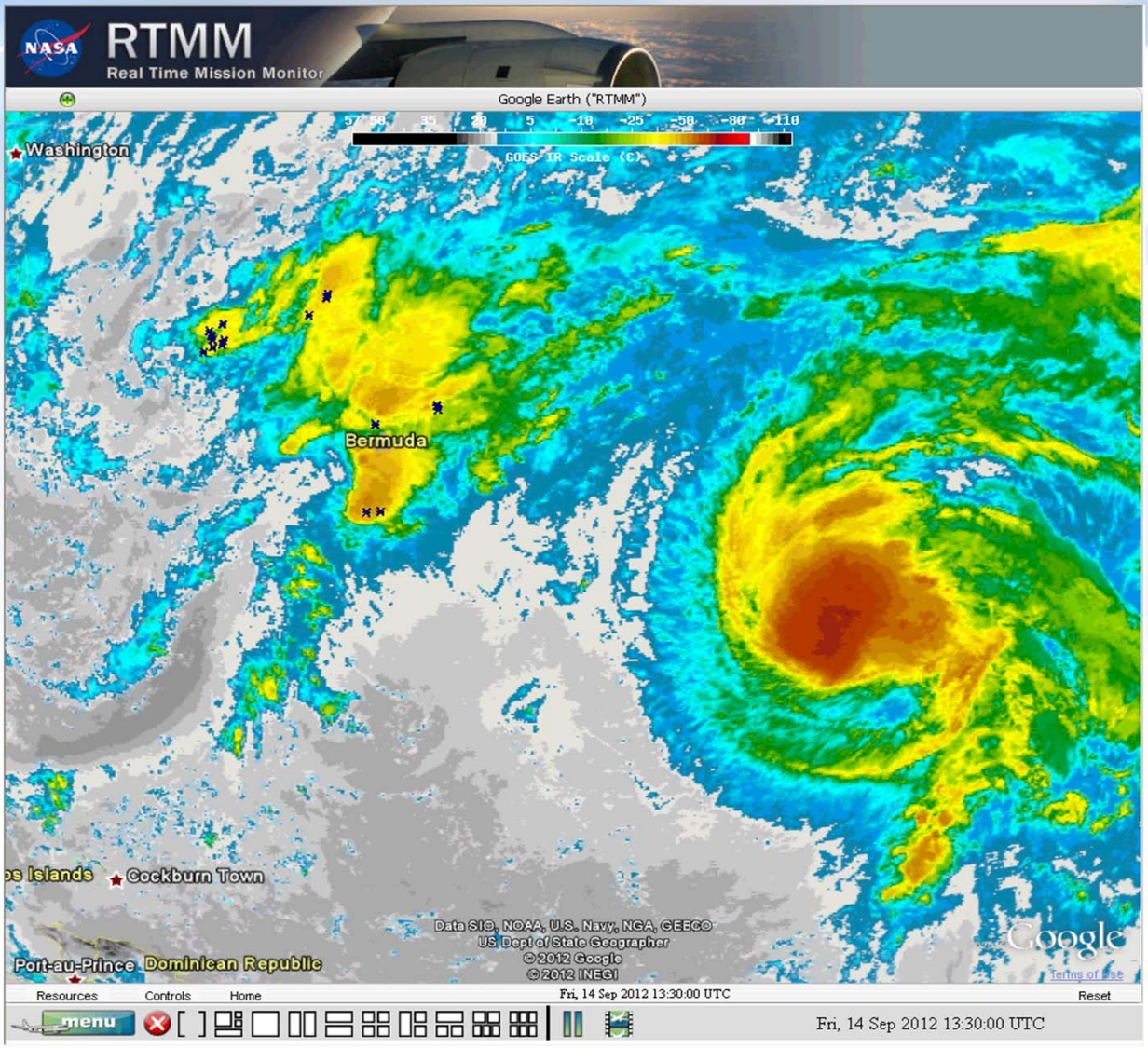
Animation includes colorized IR and lightning flashes

HS3 September 2012

Hurricane and Severe Storm Sentinel

Tropical Storm Nadine in Atlantic on 14-15 September 2012

Global Hawk



Animation includes colorized IR and lightning flashes

Collaborations & Synergies

Supported field experiments since 2010

Experiment	*Aircraft Resources*	*Dates*
GloPac (Global Hawk Pacific Mission) – MSFC used this mission as an internal dry run for RTMM	NASA Global Hawk UAV	Apr 2010
Deepwater Horizon (Gulf of Mexico Oil Spill)	NASA ER-2 NASA B200	Apr – Sep 2010
GRIP (Genesis and Rapid Intensification Processes)	NASA Global Hawk UAV NASA DC-8 NASA WB-57 Air Force Reserve C-130 NOAA P-3 NOAA Gulfstream IV NSF Gulfstream V	Aug – Sep 2010
LPVEx **(**Light Precipitation Validation Experiment)	University of Wyoming King Air	Sep – Oct 2010
WISPAR **(**Winter Storms and Pacific Atmospheric Rivers)	NASA Global Hawk UAV NOAA Gulfstream-IV	Feb – Mar 2011
MACPEX (Mid-latitude Airborne Cirrus Properties Experiment)	NASA WB-57	Mar – Apr 2011
MC3E (Mid-latitude Continental Convective Clouds Experiment)	NASA ER-2 University of North Dakota Citation University of Tennessee Space Institute Piper Navajo	Apr – Jun 2011
ACE (Arctic Collaborative Environment)	Coast Guard ships - virtual Search and Rescue planes - virtual	Prototype demo Oct 11

Collaborations & Synergies

Field Experiments in 2012

Experiment	*Aircraft Resources*	*Dates*
GCPEX (Global Precipitation Mission, GPM Cold Season Precipitation Experiment)	NASA DC-8 University of North Dakota Citation	Jan – Feb 2012
Nimbus National Science Foundation	Spear UAV	Apr & Aug 2012
HS3 (Hurricane and Severe Storm Sentinel)	NASA Global Hawk UAVs	Sep – Oct 2012 - 2014

Summary

- RTMM has evolved into a powerful and easy to use application in support of planning, situational awareness and strategic decision-making during airborne field campaigns.
- NASA is very open to sharing these capabilities with any interested group through interagency collaborations in future field activities.

Thank you.

We welcome questions and discussion.

Backup Charts

RTMM Demonstration for ACE

The Arctic Collaborative Environment (ACE) is a Technology Demonstration project with DoD in partnership with NASA

– Goal is to provide near real-time ice and climate information to DoD and all interested partners to support all types of arctic operations.

Summary of Outreach Activities

Date	Venue	Topic
December 2009	AGU Winter Meeting session on Virtual Globes – John Bailey session chair	The 2nd Generation Real Time Mission Monitor (RTMM) Development
January 2010	AMS Annual Meeting, 26th Conference on Interactive Information and Processing Systems (IIPS) Meteor., Ocean., & Hydro.	Technology Infusion for the Next Generation Real Time Mission Monitor
December 2010	Session IN07 Real Time Data at the Fall American Geophysical Union Meeting	Waypoint Planning Tool poster
March 2011	Interdepartmental Hurricane Conf. Miami	RTMM Presentation
March 2011	Ponca City, OK	RTMM overview and training for MC3E participants
June 2011	Earth Science Technology Forum	The 2nd Generation Real Time Mission Monitor (RTMM)
December 2011	Session IN51B Data Management Strategies for Airborne Science, Fall American Geophysical Union	RTMM Poster Presentation
June 2012	Earth Science Technology Forum	Waypoint Planning Tool

Acronyms (thin out)

ACE	Arctic Collaborative Environment
AGU	American Geophysical Union
AIST	Advanced Information Systems Technology
AMS	American Meteorological Society
ARCS	Al-Razaq Computing Services
BASF™	Baden Aniline and Soda Factory
CARE	Centre for Atmospheric Research Experiments
COMPASS	Common Operations and Management Portal for Airborne Science Systems
DBMS	Data Base Management System
DC3	Deep Convection, Clouds, and. Chemistry
DoD	Department of Defense
ESTO	Earth Science Technology Office
GE	Google Earth
GOES	Geostationary Observational Environmental Satellite
GPM	Global Precipitation Mission
GCPEx	GPM Cold Season Precipitation Experiment
GRIP	Genesis and Rapid Intensification Processes
HS3	Hurricane and Severe Storm Sentinel
ITSC	Information Technology and Systems Center
KML	Keyhole Markup Language
LPVEx	Light Precipitation Validation Experiment
MACPEX	Mid-latitude Airborne Cirrus Properties Experiment
MC3E	Mid-latitude Composition, Cloud and Climate Experiment

Acronyms (thin out 2)

MSFC	Marshall Space Flight Center
NCE	No Cost Extension
PHP	PHP Hypertext Preprocessor
RTMM	Real Time Mission Monitor
SEAC4RS	Southeast Asia Composition, Cloud, Climate Coupling Regional Study
SOS	Sensor Observation Service
SRL	Software Readiness Level
SW	Software
TRL/SRL	Technology Readiness Level / Software Readiness Level
UAHuntsville	University of Alabama in Huntsville
U/I	User Interface
UND	University of North Dakota
WISPAR	Winter Storms and Pacific Atmospheric Rivers
WPT	Waypoint Planning Tool
WW	World Wind